

Fully Integrated Communication Terminal and Equipment

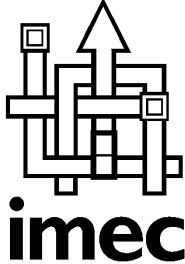
IRIS-3 Executive Summary

Specification : Executive Summary, D36A
Authors : Tom Torfs, Werner Ogiers, Thys Cronje
Document no. : P50314-IM-DL-019
Status : Issue 2
Date : July 2005
ESTEC Contract : 13716/99/NL/FM(SC)

ESTEC Technical Management: R. Weigand

European Space Agency
Contract Report

The work described in this report was done under ESA contract. Responsibility for the contents resides with the authors or organization preparing it.

	IRIS-3 Executive Summary	Do. ref.: P50314-IM- DL-019 Date: 2005/08/01 Issue: 2
Authors:	Tom Torfs, Werner Ogiers, Thys Cronje	Page 1 of 9

Contacts:

ESA- ESTEC: R. Weigand – Microelectronics Section TEC-EDM

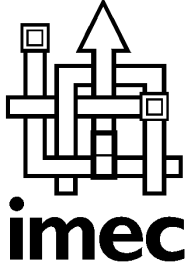
E-Mail: Roland.Weigand[at]esa.int

IMEC : Ch. Van Hoof

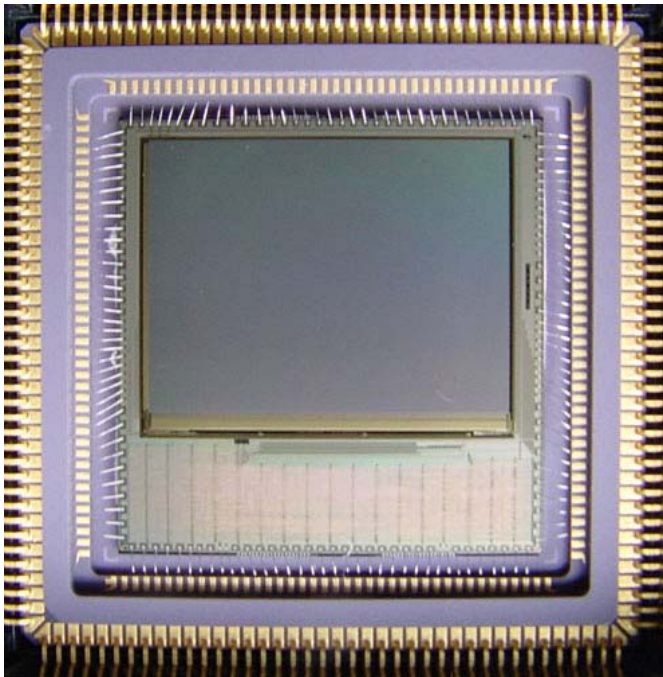
E-Mail.: Chris.Vanhoof[at]imec.be

: J. Roggen

E-Mail: Jean.Roggen[at]imec.be

	IRIS-3 Executive Summary	Do. ref.: P50314-IM-DL-019 Date: 2005/08/01 Issue: 2
Authors:	Tom Torfs, Werner Ogiers, Thys Cronje	Page 2 of 9

IRIS-3 imager overview



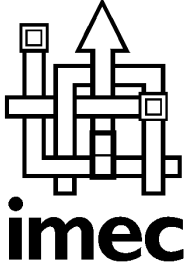
The Integrated Radiation-tolerant Imaging System 3 (IRIS-3) is a CMOS image sensor or camera with full digital interfaces that comply with spacecraft telemetry standards. It is profiled as a general purpose high-quality greyscale imaging component, to be used as a core block for miniature cameras for a wide range of spaceborne applications. These applications include robotics, low-to-medium quality earth and planetary imaging, compact lander and rover cameras, and visual telemetry.

The IRIS-3 offers enhanced functionality such as:

- A choice of on-chip digital I/O interfaces (e.g. RS-485-like, TTC-B-01, parallel, ...)
- Control of a local industry-standard SDRAM buffer for image storage
- Direct interfacing with an external compression engine

In addition to this, the IRIS-3 was developed with radiation tolerance as its target, and meets 30 krad total dose tolerance within specifications, or upto 80 krad with significantly increased supply current. The chip appears immune to latch-up.

The IRIS ASIC comprises a full custom mixed analogue-digital part: the actual pixel array along with its lowest-level timing and control circuitry and an ADC. In addition, there is a cell-based purely digital part: the local controller that drives the pixel array, captures the data from the ADC and interfaces with the outside world.

	IRIS-3 Executive Summary	Do. ref.: P50314-IM-DL-019 Date: 2005/08/01 Issue: 2
Authors:	Tom Torfs, Werner Ogiers, Thys Cronje	Page 3 of 9

IRIS-3 main features:

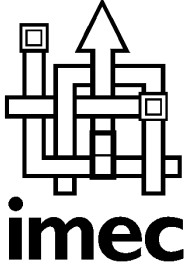
- 1024x768 pixels
- 10-bit ADC
- On-chip interface & control logic
- On-chip SDRAM controller
- Radiation tolerant

IRIS-3 camera overview



The IRIS-3 Camera is an instrument based on the IRIS-3 chip, providing the functionality of a black-and-white medium-resolution digital still-image camera combined with on-board image storage (64 megawords SDRAM, can store >50 uncompressed full-frame images).

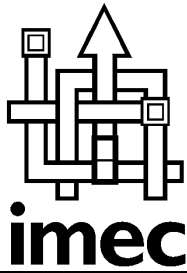
The camera interfaces to a spacecraft using a number of possible standardized digital interfaces (RS-485-like or TTC-B-01), and can employ the CCSDS-ESA packetizing protocol for telecommand and telemetry. The camera operates from a standard 28V DC

	IRIS-3 Executive Summary	Do. ref.: P50314-IM- DL-019 Date: 2005/08/01 Issue: 2
Authors:	Tom Torfs, Werner Ogiers, Thys Cronje	Page 4 of 9

sattelite bus. DC/DC converters and EMI filters are included to produce the needed 5V and 3.3V supply voltages for IRIS-3 imager chip, as well as isolation from the main 28V bus.



Sample image of IMEC buildings taken with IRIS-3



IRIS-3 Executive Summary

Do. ref.: P50314-IM-
DL-019

Date: 2005/08/01
Issue: 2

Authors:

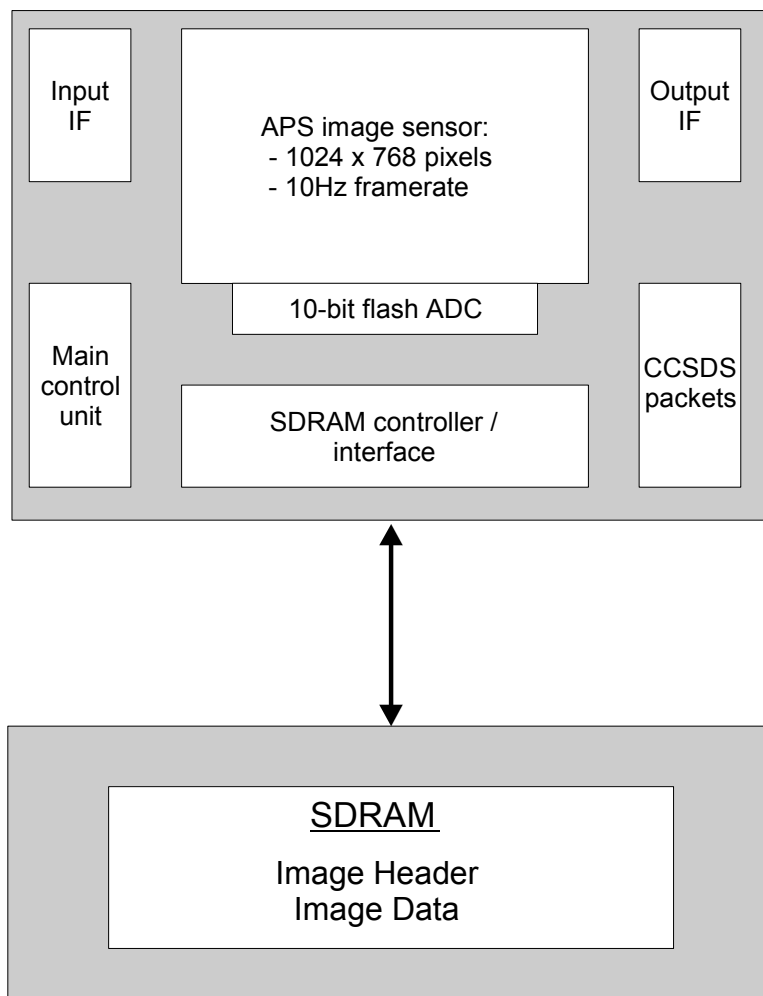
Tom Torfs, Werner Ogiers, Thys
Cronje

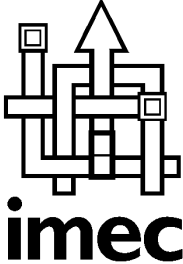
Page 5 of 9

IRIS-3 camera system block diagram

The main blocks of the camera comprise of

- The IRIS-3 image sensor with on-chip ADC and control logic: the end-user interfaces to the camera exclusively through the IRIS-3
- 64MWx16 SDRAM buffer memory to store images.



	IRIS-3 Executive Summary	Do. ref.: P50314-IM-DL-019 Date: 2005/08/01 Issue: 2
Authors:	Tom Torfs, Werner Ogiers, Thys Cronje	Page 6 of 9

IRIS-3 camera system block diagram

IRIS-3 camera qualification

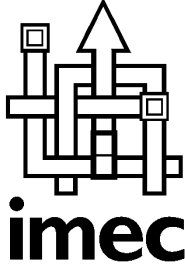
Two flight-standard cameras were built and qualified with functional and environmental tests. The cameras passed the environmental qualification tests, based on the specs of VMC in the Cluster mission:

- Temperature cycling in vacuum: -50°C .. +65°C
- Vibration testing:
 - sinusoidal low frequency: 10mm peak displacement
 - sinusoidal high frequency: 10g acceleration
 - random vibration: 0.1g²/Hz

Conclusions

As the latest in a series of ESA-funded CMOS active pixel image sensors for space use, IRIS3 is the first to combine rad-hard design techniques and system-level integration of functionality onto a single chip, allowing for smaller and simpler, yet more powerful visual monitoring cameras. The electro-optical specifications were met. The chip is tolerant to 30krad total dose irradiation, and appears immune to latch-up.

Two prototype cameras were built and successfully qualified through environmental and functional testing. These cameras operate from a standard 28V satellite supply and make use of a new style of housing as compared to the VMC cameras.

	IRIS-3 Executive Summary	Do. ref.: P50314-IM-DL-019 Date: 2005/08/01 Issue: 2
Authors:	Tom Torfs, Werner Ogiers, Thys Cronje	Page 7 of 9

Appendix: main IRIS-3 specifications

Main IRIS-3 specifications

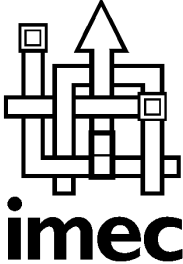
format	1024x768 pixels
pixel size	15 μ m x 15 μ m
ADC	10 bit
pixel rate	12.5MHz
frame rate	12 full frames/s, 40 quarter frames/s etc.

Electro-optical specifications

voltage conversion factor	10.4 μ V/e-
quantum efficiency	25% (including fill factor effects)
saturation charge	120000e-
linear region	85000e-
fixed pattern offset	<0.09% of full-scale (local), <0.57% (global)
pixel response non-uniformity	<0.57% of FS (local), <3.48% (global)
readout noise	52e-, 550 μ V
signal swing	1.3V
dynamic range	67dB
dark signal	2200e-/s, 23mV/s, 56 bit counts/s, 155pA/cm ²
power	600mW

Radiation tolerance specifications

total dose radiation	>80 krad focal plane 30 krad logic; 80 krad with increased power consumption
single-event latchup	immune until >11000 heavy ions/s/cm ²
single-event upsets	occur at >10 heavy ions/s/cm ² ; triple-protected long-term settings not affected

	IRIS-3 Executive Summary	Do. ref.: P50314-IM-DL-019 Date: 2005/08/01 Issue: 2
Authors:	Tom Torfs, Werner Ogiers, Thys Cronje	Page 8 of 9

IRIS-3 camera (ICC) specifications

Image buffer size	50 uncompressed full frame images
I/O interfaces	serial command and data, subset of IRIS-3 interfaces: RS-485 and TTC-B-01
Lens	12.2 mm, f/5, FOV 37.9x29° (modified VMC lens)
Housing	Aluminium, new design
Mass	555g-563g
Supply voltage	28V DC
Power consumption	200 mA @ 28 V = 5.6W peak
	115 mA @ 28 V = 3.2W idle
Temperature range	-50°C .. +65°C, operational and non-operational
Connectors	DSUB-9: power DSUB-25: signal I/O